
Space Weather Technical Forecast

Issued on Wednesday, 07 February 2024 at 13:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Moderate activity expected with M-class flares/R1-R2 Radio Blackouts. Chance of isolated X-class flares/ R3 Radio Blackouts, mainly Day 1 (07 Feb).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with isolated M-flares, the peak flare a M5.1 at 07/0331UTC from AR3575. There are twelve sunspot regions on the visible disc, however the majority of these are small and relatively stable with only two regions of note. AR3576 is a large and active region on the southeast disc, with a complex lead portion that includes a strong, sheared, delta spot as well as a minor delta spot. Significant magnetic looping is evident in SDO imagery between this region, and several other regions on the southeast disc in close proximity to AR3576. AR3575 is a smaller but still complex region and has been responsible for the M-flares in the past 24 hours. The viewing angle and position of this region in the southwestern disc precludes an accurate analysis, however the delta configuration of the trailing spot is still apparent.

Several CMEs left the disc during the period which may have produced Earth-directed components. The large halo CME visible on coronagraph imagery from around 06/1200 UTC has been assessed as far-sided. Analysis and modelling of a narrow filament lift-off from the center northern disc at a similar time suggests a miss. A CME that left the disc from near AR3575 06/1830 UTC is projected to miss, however a glancing blow may be observed late Day 3 (09 Feb) or early Day 4 (10 Feb). A CME that left the disc from near AR3575 early on Day 1 (07 Feb) has been analysed and awaits Enlil modelling.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1 were initially indicative of a fast wind, likely from CH96/+ and possible weak transient influence, solar winds slightly elevated at just under 500km/s. A slight and gradual easing of winds was observed around 07/0000 UTC with values since remaining 430-470km/s. Density was initially average but has predominantly been below average. Interplanetary Magnetic field (IMF), Bt, was weak 5-8nT. The north-south component Bz, has weakly fluctuated between +6nT and -5nT, but been broadly positive. Phi angle was mostly positive (away from the Sun). Geomagnetic activity was Quiet (Kp0-2).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux became slightly elevated following the M-class flare early on 06 Feb but remained well below the S1 threshold and has returned to background. GOES16 high energy (greater than 2MeV) electron flux was largely at background. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold.

Four-Day Space Weather Forecast Summary

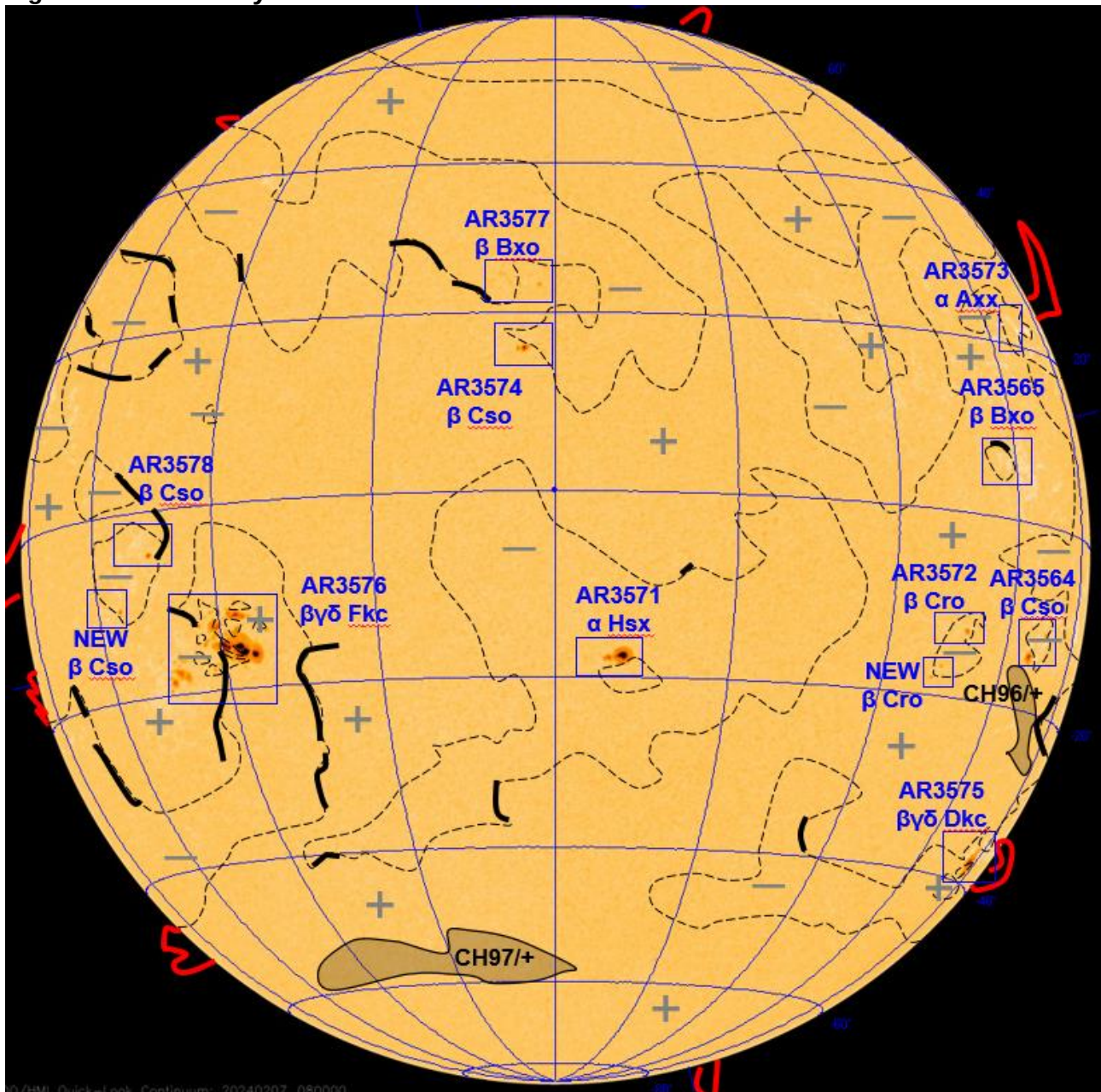
Solar Activity: Moderate activity expected, with further M-flares and an initial chance of X-flares. These most likely from two large and complex regions, either AR3576 in the southeast, or from AR3575 in the southwest. The risk reduces slightly as AR3575 departs the disc Day 2 (08 Feb).

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Solar Wind / Geomagnetic Activity: Any residual enhancement to solar winds from CH96/+ is expected to wane through Day 1 (07 Feb), with wind speeds trending towards slow-ambient levels. A CME that left the Sun in association with the M4.2 flare in the morning of 06 Feb may provide a slight glancing blow late Day 3 (09 Feb) or early Day 4 (10 Feb). The CME associated with the M5.1 flare earlier on Day 1 may give some slight enhancement at Earth later in the period, but this is both low confidence and a low probability. Geomagnetic activity is expected to be mostly Quiet (Kp 0-2), with a chance of Unsettled intervals (Kp 3) and a very slight chance of a G1/Minor Geomagnetic Storm interval (Kp 5), should any CME enhancement occur Days 3-4.

Energetic Particles / Solar Radiation: High energy proton flux has the potential to rise in response to any significant flares, most likely from AR3575 or AR3576. AR2576 will move into a more central location through the period, becoming the main risk region. Significant flares from these regions result in a slight chance of exceeding the S1/Minor Radiation Storm level. High energy electron flux (greater than 2MeV) is expected to remain mostly at background with the associated 24 hour fluence persisting well below the Active threshold.

Figure 1. Solar Analysis Valid 07/0800 UTC.



Key: Filament ___, Prominence ___, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

Solar winds are currently seeing some slight enhancement from the small coronal hole, CH96/+, close to the western limb. Any HSS enhancement is anticipated to wane through Day 1 (07 Feb), with speeds falling from slightly elevated around 450-480km/s towards slow-ambient levels around 400 km/s. No further HSS enhancements are anticipated through the period. This is supported by MOSWOC Enlil.

The CME that left the Sun in association with the M4.2 flare early on 06 Feb may give a glancing blow late Day 3 (09 February) or early Day 4, bringing a very slight chance of a G1/Minor

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Geomagnetic Storm interval. However, a miss is more probable. The CME associated with the M5.1 flare at 07/0330 UTC has been analysed and awaits Enlil modelling. Should an Earth-directed component be attributed to this CME region, the Drag-based model suggests an arrival time of any enhancement early Day 3 (09 Feb). This is low confidence.

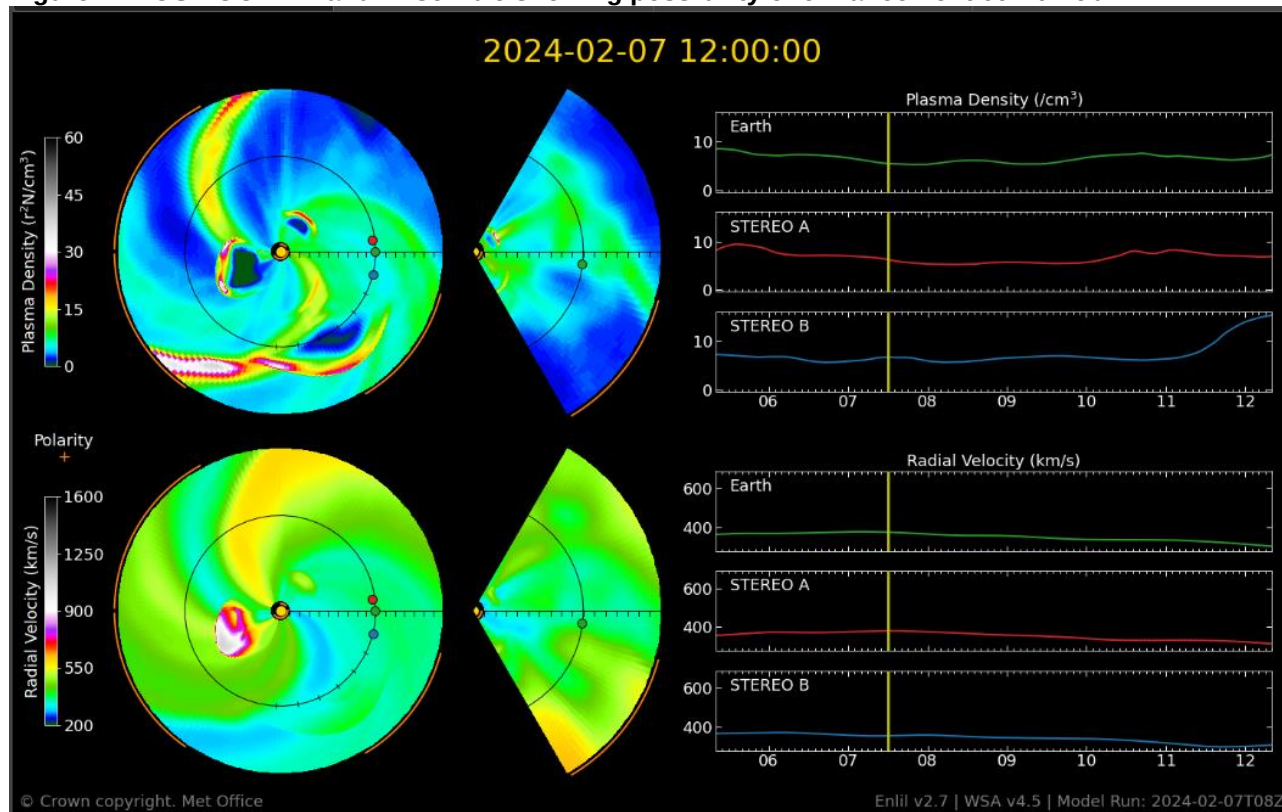
Geomagnetic activity is expected to remain largely Quiet (Kp 0-2), but with a chance of Unsettled (KP 3) intervals and a very slight chance of G1/Minor Geomagnetic Storm (Kp 5) intervals should either of the aforementioned CMEs give glancing blows.

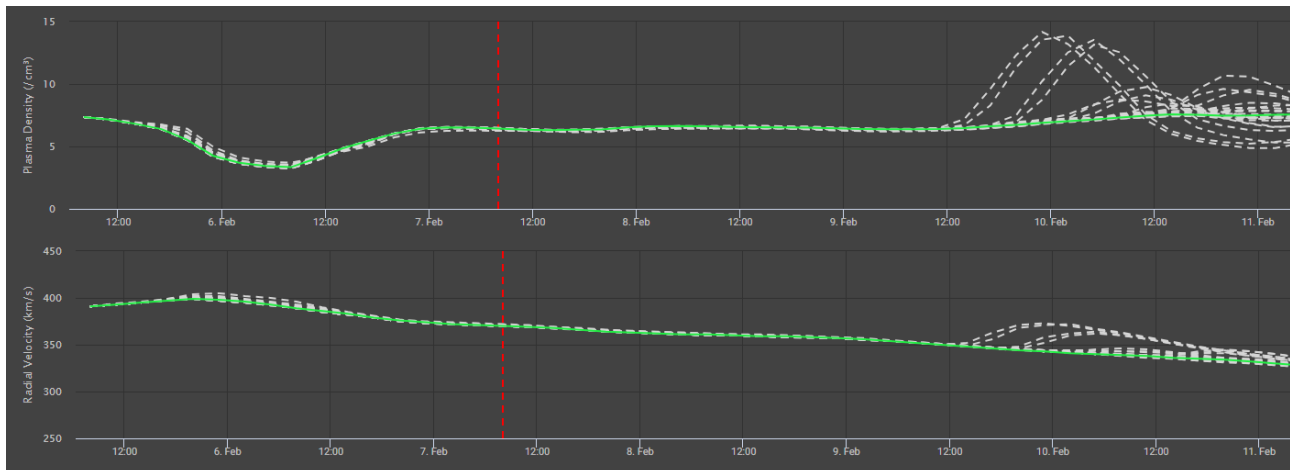
Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	1	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil CMEs expected.

Figure 2: MOSWOC Enlil and Ensemble showing possibility of enhancement 09-10 Feb.





Radio Blackouts - X-Ray Flares:

Solar activity is expected to persist at Moderate levels throughout, with a continued risk of M-class flares. Although there is a chance that activity may increase to High should any isolated X-class flares be emitted. The main risk regions for flaring are AR3576 in the southeast, and AR3575 approaching the southwest limb.

There are twelve regions currently on the solar disc, with the previously mentioned regions of AR3575 and AR3576 the only regions of significance. Two regions are currently unnumbered, one small Cso/Beta region has emerged in the southeast, close to AR3576, whilst another unnumbered region (Cro/Beta) continues to develop on the southwest disc. The majority of regions on the disc however, are small, stable and simple.

AR3576 (Fkc/Beta-Gamma-Delta) is a large and complex region in the far southeast disc, this region has a strong delta spot within its lead group which has shown signs of shearing. There are other marginal delta spots also within this leading group. Also visible on SDO-AIA imagery is evidence of a broad area of magnetic looping, along with an identifiable flux-rope and ongoing dynamical changes, this suggests the ongoing risk of notable flares. AR3575 (Dkc/Beta-Gamma-Delta), while smaller, produced the recent M4.2 and M5.1 flares. This group also has a visible delta spot, along with evidence of magnetic looping. Furthermore, any apparent reduction in spot area may be due to its southern location, along with it approaching the western limb leading to an oblique viewing angle. It is due to rotate over the southwest horizon late Day 1 into Day 2 (07-08 Feb), with a consequent slight decrease in flare risk.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	70	70	70
Very Active	R3 to R5 X Class	No	25	20	20	20

Figure 3: GOES16 & GOES18 X-Ray Trace



Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is currently at background levels. There is a risk of proton flux rising in response to any further notable flares, with a slight chance of exceeding the S1/Minor Radiation storm level. Initially the main risk is from AR3575, due to its position on the southwest of the disc, with the risk persisting as this moves over the western horizon later Day 1 or Day 2 (07-08 Feb) before gradually reducing. However, AR3576, which is currently in the eastern disc, will transit to a more central disc location, increasing the potential for proton events occurring due to any notable flares from this region. The overall effect is for risk levels to be maintained throughout.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	20	20	20	20
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) as observed by GOES-16 is expected to persist at background levels. There is a slight chance of brief Moderate flux Day 2 (08 Feb) onward during the diurnal peak. There is a low probability of CME effects being observed at Earth Days 3-4 (09-10 Feb) which may act to suppress the electron belt towards the end of the period.

The associated 24 hour electron fluence is expected to remain well below the Active ($1\text{e}8$ integrated flux) threshold, as suggested by MOSWOC's REFM, which is currently thought to be giving good guidance.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	1	1
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM showing forecast values well below Active threshold (threshold not visible on Y-Axis)

